The Sulphur Test - Background and Interpretative Criteria

J. W. Hamm

Sulphur fertility research in Saskatchewan as summarized by Ukrainetz (1969) has indicated that a significant proportion of the soils in this province are deficient or potentially deficient in S for common field crops.

Until recently, field response studies were not related to available S levels because of the lack of reliable techniques for the determination of SO_4-S in soil extracts. This problem has recently been solved (Bettany and Halstead, 1972) resulting in the introduction of a S-test in the fall of 1971.

Joint efforts of the Department of Soil Science, Canada Agriculture and the Fertilizer Industry have resulted in the accumulation of a substantial amount of field correlation data in support of the interpretative criteria for this test (Table 1).

This paper describes the S- test procedure, the field correlation data collected to date and the current S- requirement guidelines.

The Sulphur Test Procedure

The analytical procedure has previously been described in detail by Hamm, *et al*. (1972). Soil samples are segregated on the basis of soil zone, texture and electrical conductivity of a 1:1 soil-water suspension. The following soils and samples are eliminated in that order:

1) All soils belonging to the Chernozemic Brown and Dark Brown Great Groups.
2) Soils in the Chernozemic Black Great Group having a surface texture finer than clay loam.
3) Soil samples having an electrical conductivity greater than 1.0 mmhos/cm.

Extraction is accomplished by shaking 25 g soil with 50 ml extracting solution for 30 minutes on a reciprocating shaker. The

Table 1

Summary of Field S- Correlation Research

Conducted in Saskatchewan (and Manitoba)

Indicator Crop	No. of Experiments	Soil Association Included
Wheat	20	Sylvania (4), Loon River (1), Waitville (1), Elstow (1), Fox Valley (2), Sceptre (3), Hatton (3), Haverhill (5).
Barley	4	Melfort (1), Tisdale (1), Loon River (1), Waitville (1).
Buckwheat	2	Melfort (1), Canora (1).
Rape (Sask.)	22	Melfort (1), Canora (1), Carrot River (3), Elstow (2), Asquith (1), Nipawin (6), Yorkton (1), Waitville (2), Bradwell (1), Loon River (2), Shellbrook (1), Oxbow (1).
Rape (Man.)	12	Pine Ridge (1), Manitou (2), Altamont (1), Stockton (1), Newdale (3), Granville (1), Holland (1), Pembina (1), Erickson (1).

suspension is then filtered using Whatman #30 filter paper. Ten ml of the filtered extract is then placed into 15 ml graduated plastic centrifuge tubes and treated with one ml of 2% sodium peroxide solution added slowly with a pipette. This step considerably reduced the non-alkaline metal cation and organic matter content of the extract and aliminates their interference in the $BaSO_4$ precipitation reaction. The solution is allowed to stand for approximately five minutes until a gelatinous precipitate has formed. This precipitate is removed by centrifugation and the supernatant diluted three times with 0.05 N HCl into an AutoAnalyzer sample cup using an Auto-dilutor.

The determination of SO_4 in the treated extract is achieved in two stages using the automated system illustrated in Fig. 1. The extracts are first presented to the turbidimetric manifold for assay in the 2 to 20.0 μg/ml S range. Extracts which contain less than 2 μg/ml S are then assayed by the nephelometric manifold which is operated simultaneaously. This system permits the accurate determination of extractable soil SO_4 in the 1.0 to 120 μg S/g soil range. The analytical curves for the two methods are prepared by diluting the respective sets of standards three times with 0.05 N HCl, as described above for treated extracts, and presentation to the manifolds.

Field Sulphur Correlation Results

Sulphur test correlation data was examined in several ways. Relationships between per cent yield and extractable SO_4-S in 0-24 inch depth for cereals (Fig. 2) indicate that these crops, generally, did not respond to S on the soils examined. Additional field trials, however, are required on soil containing less than 15 lb SO_4-S/Ac.

Similar data for rape, mustard, flax and alfalfa (Fig. 3) indicates that these crops are considerably more responsive to applied S than cereals. It also suggests that the current 32 lb SO_4-S/Ac critical level is adequate for these crops.

Sulphur Status of Saskatchewan Soils

A summary of 3,232 fields sampled in 1971-7s and 1972-73 for the complete tests delineated the relative extent of S- deficient or potentially deficient soils in Saskatchewan (Table 2). These data indicate that approximately one per cent of the soils in the Brown and Dark Brown zones *may* be deficient in S- for cereals and ten per cent, possibly, are similarly deficient for oil seeds and legumes. Since no record of S- response in the Brown and Dark Brown zones is available, these values are questionable. The proportion of fields testing low in S- increased with degree of soil degradation. Most of the soils in the Black, Grey Black and Grey zones requiring additional S- were coarse or medium textured. The dominant soil associations included were: Hamlin,

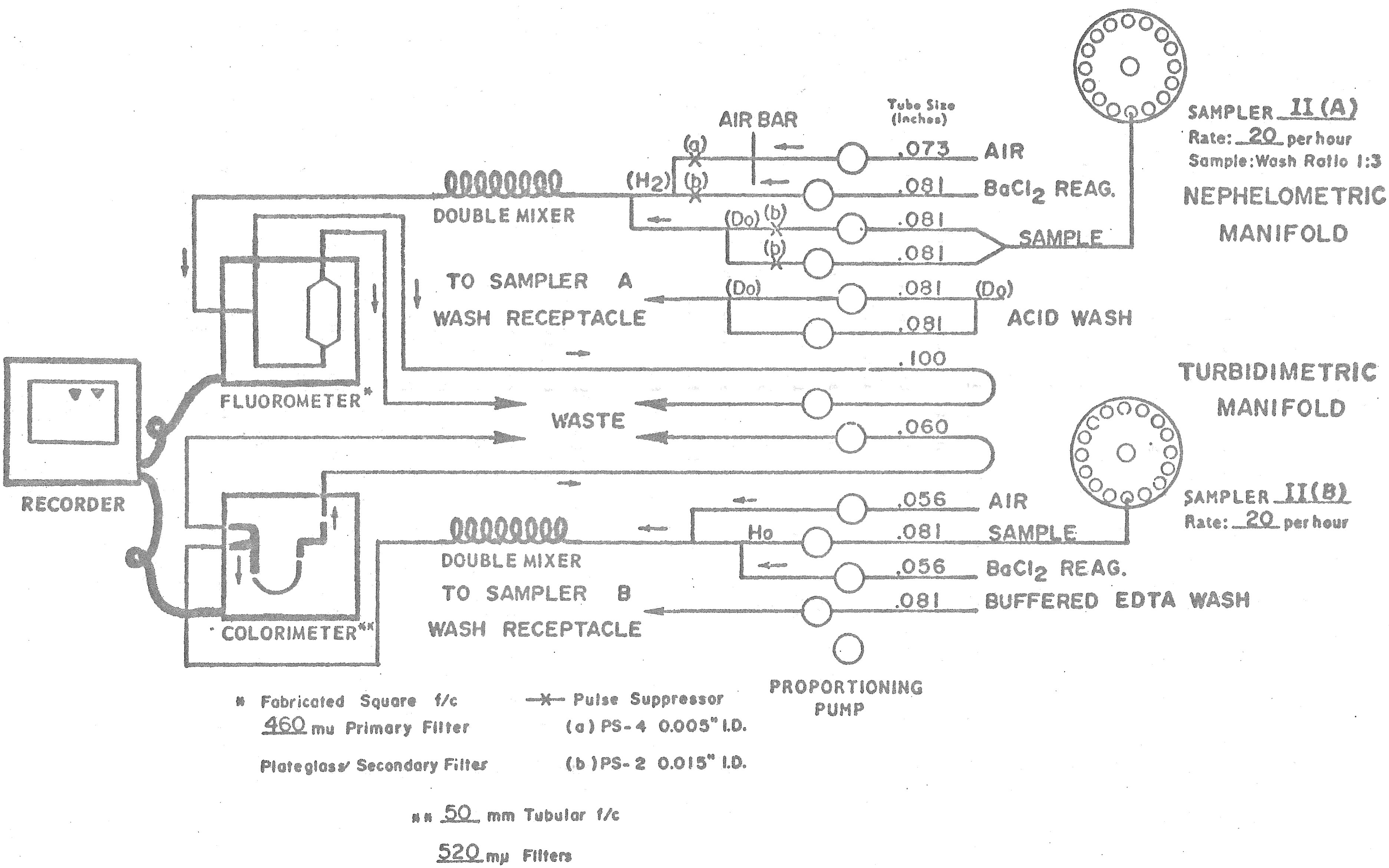

Figure 1. Flow Diagram for Automated Determination of $SO_4^{=}$

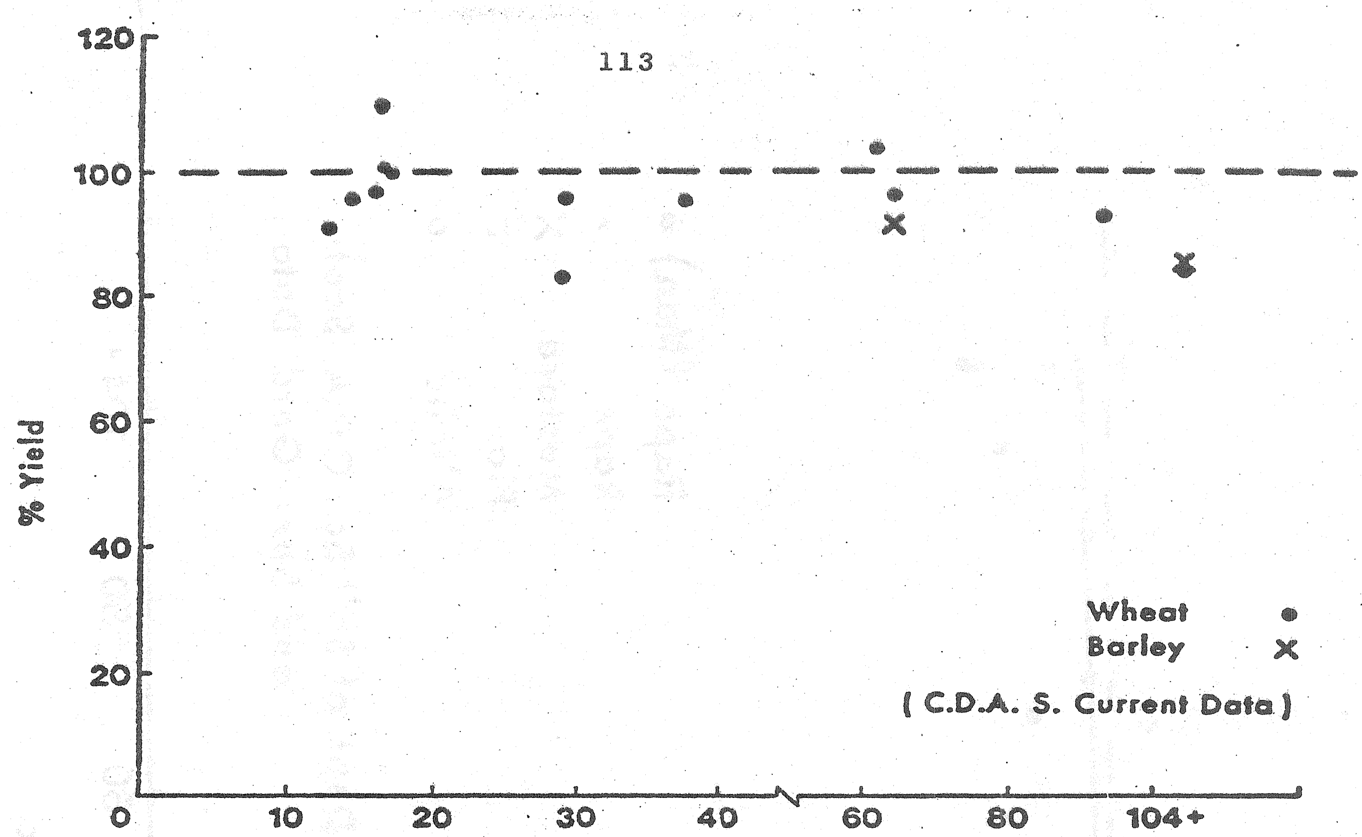

Figure 2a SO4-S in 0-24" (lb/Ac)

Cereal Response to S on Brown and Dark Brown Soils in Saskatchewan.

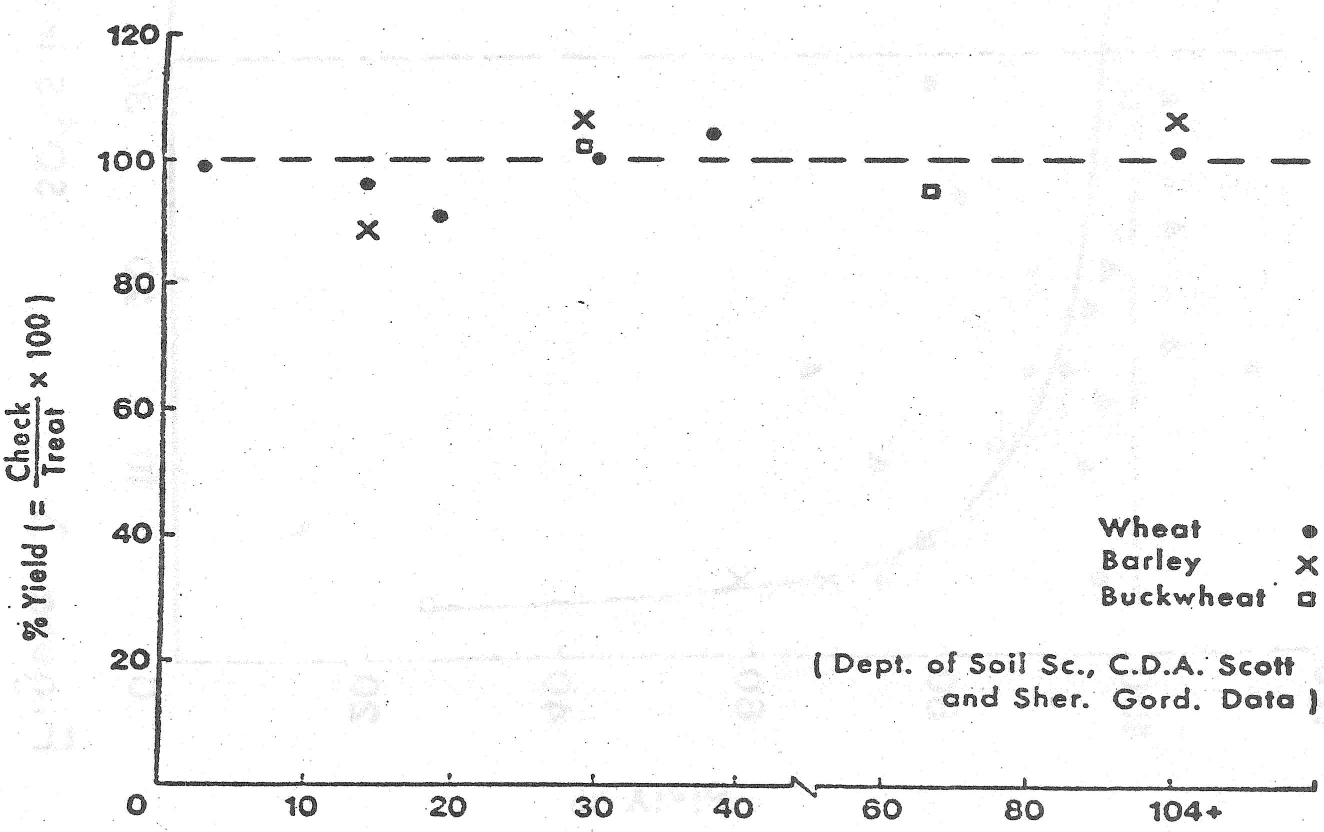

Figure 2b. SO4-S in 0-24" Depth (lb/Ac)

Cereal Grain Responses to S on Black, Gray-Black and Gray Soils

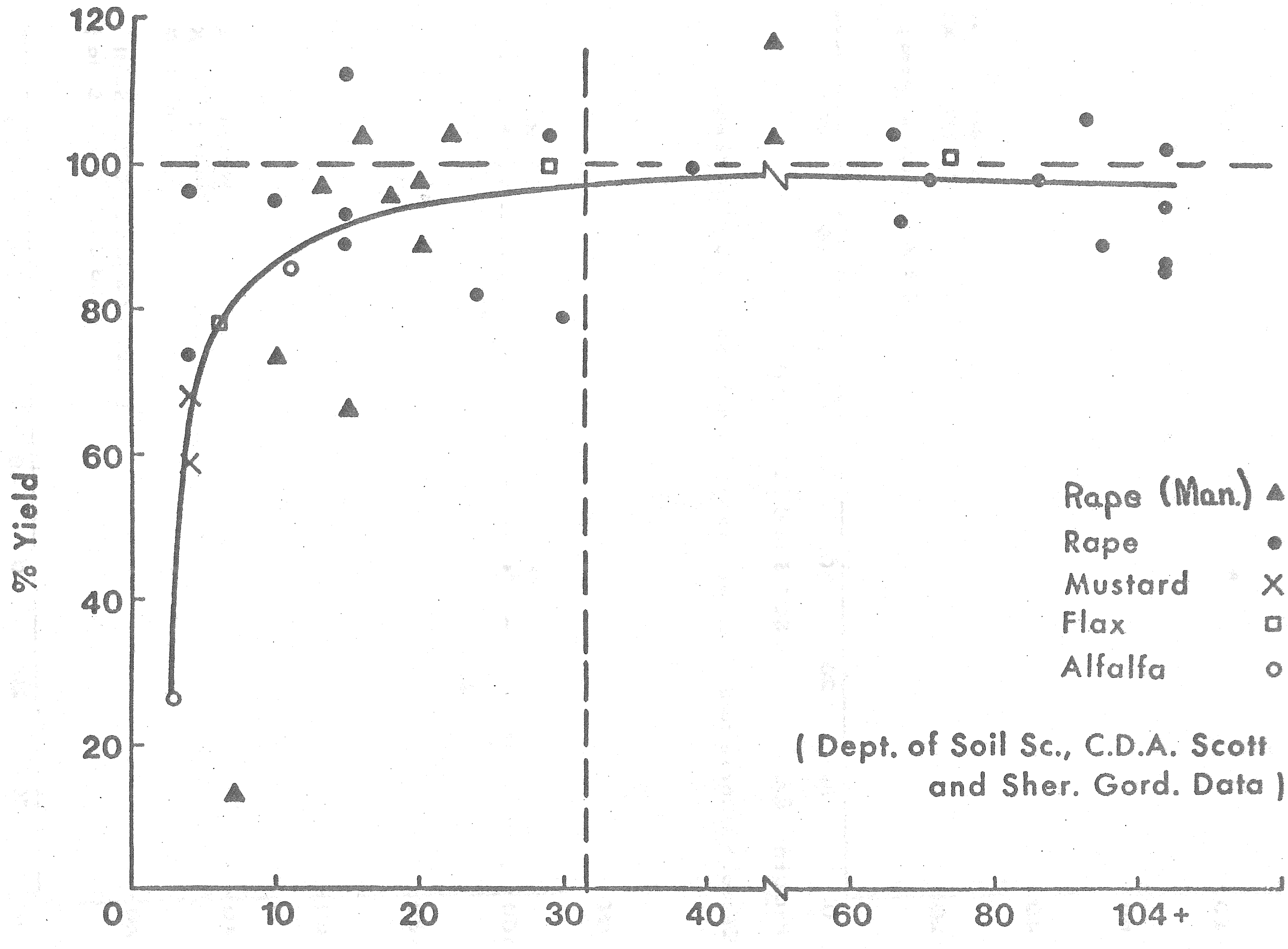

Figure 3

Oilseed and Alfalfa Response to S on Black, Gray-Black and Gray Soils of Saskatchewan.

114

Table 2

Sulphur Status of Saskatchewan Soils Based on 1971-72 and 1972-73 Soil Test Data (3,232 fields).

Soil Zone	Per cent of Fields Sampling Requiring Additional S	
	Cereals	Oil Seeds and Alfalfa
Brown	1	11
Dark Brown	1	10
Thin Black	3	12
Thick Black	0	3
Grey Black	9	18
Grey	13	23

Meota, Whitesand, Carrot River, Makwa, Nipawin, Pine Sand, Shellbrook, White Fox, La Corne, Loon River, Sylvania and Waitville.

This review provided some evidence that mineralization of SO_4-S was apparent in summerfallow as indicated by differences between average fallow and stubble values. An average increase of three lb SO_4-S/Ac was calculated for the Black, Grey Black and Grey zones. Increases were greatest in soils high in organic matter. Since these differences are small it is suggested that soils containing more than 40 lbs SO_4-S to 24 inches need not be sampled every year.

Conclusions

The summary of soil test and field response data collected in Saskatchewan to date suggest that the S- test as described above is delineating the soils known or suspected to be S- deficient. More field research is required, however, to substantiate the proposed S-requirement guidelines.

Some preliminary conclusions can be drawn from the data available:

1. The critical value of 32 lb SO_4-S/Ac to 24 inches for oil seeds and legumes is adequate. The critical value for cereals (16 lb SO_4-S) should be adjusted downward.
2. The survey of Brown and Dark Brown soils sampled indicated that very few fields <u>may</u> be S- deficient in harmony with the work at C.D.A., Swift Current. Therefore, the elimination of these soils from routine analysis until S- response is recorded on them seems justified.
3. Some mineralization of S- is apparent in soils with appreciable organic matter content. However, changes were small leading to the recommendation containing greater than 40 lb SO_4-S to 24 inches could be tested in four to five year intervals.
4. Additional research on all crops is required, with particular emphasis on soils testing less than 20 lb SO_4-S/Ac.

References

1. Ukrainetz, H. A. 1969. Proc. Natl. Soil Fert. Comm. (W. Sec.) Mtgs. Edmonton, Alta.
2. Bettany, J. R. and Halstead, E. H. 1972. Can. Jour. Soil Sci. 52:127.
3. Hamm, J. W., Bettany, J. R. and Halstead, E. H. 1973. Comm. Soil Sci. Plt. Anal. (In press).